as Carnegie research scholar, its publication having been delayed by his appointment to the chair of metallurgy at Montreal. The memoir covers thirty-six pages. The burnt structure of very much overheated steel is shown to be largely due to the partial melting which results from heating the steel above a given temperature. This melting causes brittleness directly, and indirectly by the admission of oxygen to the steel. According to American metallurgists the latter stage would alone be called burning, but as the effect of partly melting the steel is quite distinct from that of overheating below the zone of partial fusion, the author would prefer to apply one word to the whole of the changes that take place in this zone. If the word burning is still employed, it should be remembered that it is essentially a partial melting of the steel, though often accompanied by oxidation. The following stages have been recognised :—(1) overheating (below the point of incipient fusion); (2) partial melting, called burning; (*a*) merely producing segregation of carbon in the joints; (*b*) accompanied with liquation and producing flaws; (*c*) further liquation and oxidation in the flaws. (1) Steel that has merely been overheated can be completely restored by heating just above its highest recalescence point and allowing to cool. (2) Steel in the stage (*a*) can be restored by suitable annealing; in the stage (*b*) forging would also be needed; and in stage (*c*) it would be restored with great difficulty, if at all.

The paper on the heat treatment of steel submitted by Dr. William Campbell (New York) is a report on research carried out by the author as Carnegie research scholar. It forms a pamphlet of ninety-three pages. The steel used contained 0·50 per cent. of carbon, 0·98 manganese, 0·094 silicon, 0·098 phosphorus, and 0·08 sulphur. The structure of the steel used was found to depend upon the two constituents present, namely, the ferrite and the pearlite. The pearlite will certainly show the finest structure when the steel has been heated to just above Ac_1, or when it has been transformed into martensite. Heating to temperatures above this point will cause a coarsening of the structure. The higher the temperature the coarser the structure. Above Ac_1 the ferrite begins to diminish in size, due to its being dissolved in the martensite. This will continue until the whole of it is dissolved, when the change Ac_{2-3} is complete. Then the finest structure of the whole will be found where these two changes balance. This point is apparently just below the point where Ac_{2-3} is complete. The best finishing temperature is such that the bars leave the rolls as near Ar_{2-3} as possible. The bars would necessarily have to be drawn from the furnace at a higher temperature, which is about 740° C. in this case, allowing for a cooling of, say, 40° C. or more during rolling. In comparing the results obtained with those of pure carbon steel, the effect of the manganese present must be taken into consideration.

An animated discussion followed the reading of these papers on heat treatment, in which Messrs. Westgarth, Ridsdale, Lange, Price-Williams, L. N. Ledingham, and Hadfield took part.

The probability of iron ore lying below the sands of the Duddon Estuary formed the subject of a paper by Mr. J. L. Shaw (Whitehaven). He adduces evidence to show that there is a limestone area probably carrying large bodies of ore, and advocates the putting down of exploratory boreholes. In the discussion Mr. G. J. Snelus gave further particulars of geological interest.

The paper by Mr. W. F. Pettigrew on coal as fuel at Barrow-in-Furness contained much of interest. In that district at the present time coal is obtained from Cumberland, Lancashire, and Yorkshire. As the prices at the pit, the cost of carriage, and the quality of the coal from these districts vary considerably, the author has carried out several experiments to find the relative value of coal obtained from the districts before mentioned, also from various parts of Scotland and South Wales. Experiments carried out with a locomotive showed that the sample of Yorkshire No. 1 gave the best results. This coal has excellent steaming qualities, is very clean, with an open clinker, and low percentage of ash. The Welsh coal was also good when tried, and equal in all respects to the Yorkshire coal, and would no doubt give even better results if properly fired, which was not the case during the trials, the men having had practically no experience with this kind of coal. The Cumberland coal was good, particularly one sample, but this was not found suitable for locomotive purposes. The other sample of Cumberland coal gave fairly good results, but it is a dirty coal, and necessitates the frequent cleaning of fires. The Lancashire samples were in some cases very good steaming coal, with a moderately low consumption, but several samples gave very bad results, and were quite unfit for locomotive purposes. The Scotch coals tested were fairly good, but in most cases a very heavy consumption was recorded. They are quick burning coal and dirty, but with an open clinker, which did not interfere in any way with the steaming. The consumption was from 20 to 40 per cent. higher than the Yorkshire coal.

Mr. C. H. Ridsdale (Middlesbrough) read a lengthy paper on the diseases of steel. In it he collated various types of defects, and traced them to their origin.

Mr. H. Ehrhardt, of Düsseldorf, contributed a paper describing a process for making weldless steel pipes and shells by which rings up to 8 feet in diameter and 10 feet in length are manufactured.

The regulation of the combustion and distribution of the temperature in coke oven practice was dealt with in a paper by Mr. D. A. Louis. Illustrations were given to show the design and character of the Brunck and v. Bauer coke ovens, two ovens of new design.

The influence of silicon on iron was dealt with in a paper by Mr. Thomas Baker. He prepared a series of alloys of silicon and iron with traces only of other elements, and studied the micro-structure and physical properties of each. Although the addition of silicon to iron increases the elastic limit and tenacity of iron, such increase is only obtained by loss of ductility, which loss, provided the material has been well annealed, is very small until the silicon reaches 3 per cent., after which it becomes very great, the ductility almost becoming zero with 4 per cent. silicon. The alloys gradually increase in hardness with the addition of silicon, and after exceeding 5 per cent. silicon require great skill and care in machining in order to avoid fracture of the bar. As the percentage of silicon increases the permeability for low magnetic fields increases, and the coercive force and hysteresis loss decrease. Prof. T. Turner (Birmingham) was the chief speaker in the discussion.

The proceedings concluded with the customary votes of thanks to the reception committee, and an invitation, tendered by Mr. Kirchhoff, of New York, on behalf of the American societies, that the Institute should meet in the United States next autumn was accepted.

In connection with the meeting an elaborate programme of visits and excursions was arranged, including the works of the Barrow Hæmatite Steel Co., the Askham blast furnaces, the Hodbarrow mines and sea-wall, the naval construction works of Vickers, Sons and Maxim, the Furness Railway locomotive works, the North Lonsdale iron works, and to Lake Windermere, Grasmere, and Blackpool. The social functions included a conversazione given by the Mayor, a ball by the reception committee, a garden party by Mr. Victor Cavendish at Holker Hall, and an illuminated *fête* at Furness Abbey.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

SATURDAY, October 31, has been fixed for the holding of a convocation of the University of Oxford for the purpose of electing a Chancellor of the University in the place of the late Marquis of Salisbury.

ARRANGEMENTS for next term have been published in connection with the Oxford University School of Geography. Nine lectures a week by different members of the staff will be given in various branches of geographical science, and practical instruction to supplement several of the courses of lectures has been arranged. A geographical scholarship of the value of sixty pounds is to be competed for on October 14, and candidates must have taken honours in one of the final schools of the university. Courses of instruction are now given also in preparation for the university certificate in surveying, and to meet the requirements of students reading for the university diploma in education.

THE report of the Board of Education for 1902–3 shows that during the session 1901–2 the total number of students receiving science and art instruction under the Board was 291,758. The total number of schools in which the teaching was given was 2061. The grants paid during the year amounted to 314,212*l.*, of which 143,671*l.* was paid upon attendances. From the same report we learn that great progress has been made with the new buildings for the Royal College of Science. It is hoped the work will be complete in two years' time.

THE University College at Reading continues its useful work in the adjoining counties in connection with field trials and lectures at rural centres, and the work of the agricultural department is of a kind to secure the confidence of practical men. Instruction in dairy farming and dairying is given in cooperation with the British Dairy Institute; the College Poultry Farm at Theale is available for students who desire to obtain a practical acquaintance with poultry-keeping; and there is a college garden for horticultural practice and instruction.

AT the forthcoming opening of the medical schools, the following will deliver addresses:—At the St. George's Hospital medical school on October 1, Dr. W. R. Dakin; at King's College, London, on October 1, Sir John Alexander Cockburn, K.C.M.G., on "Imperial Federation and its Physiological Parallels"; at Guy's Hospital Physical Society, on October 10, Dr. J. F. Goodhart; at the Middlesex Hospital on October 1, Mr. William Hern; at the Medical Faculty of University College, London, on October 5, Prof. E. H. Starling, F.R.S.; at the University of Liverpool on October 1, Sir Dyce Duckworth; and at the University College, Sheffield, on October 15, Sir Michael Foster, K.C.B., F.R.S.

THE report on the work of the Sir John Cass Technical Institute for the session ending last July, and the recently published syllabus of the classes to be held during next winter together show that this young polytechnic is doing excellent work. Many of the students are engaged in technical pursuits during the day. For example, quite half of the students of chemistry are employed in some form of chemical technology, and an examination of the entries of last winter in the metallurgical department shows that one was the head of a firm of bullion refiners, three were managers in metal refining works, five were chemists engaged in metallurgical industries, three were foremen in metallurgical works, and others clerks or samplers in works or trades associated with metals. Among others of a thoroughly practical nature arranged for next session may be noticed a course of practical instruction in glass blowing suited to the requirements of chemists, physicists, teachers, and those engaged in the making of glass apparatus and instruments.

IN his report for the year 1903 on secondary education in Scotland, Sir Henry Craik, K.C.B., says there has again been a gratifying increase in the number of schools presenting candidates in science at the leaving certificate examination, and also in the total number of candidates presented. The examiners report that there is need to repeat once more the warning to teachers against taking up practical work of which the theory is beyond the comprehension of their pupils, or has not been made clear to them. The methods of examination differ in some important points from those regulating the system in regard to other subjects. The examination is chiefly oral and practical, and it is shaped in the case of each school by the curriculum of that school. It is interesting to find that the most satisfactory work appears to be done in the schools the profession of which is comparatively modest. In practical science, as in all educational subjects, the special discipline given is better got from a thorough study of one branch than through a too ambitious attempt to cover a very wide field. The chief examiner is inclined to recommend that, unless the time available during the third year's course is more than four hours a week, the whole of it should be devoted to one subject instead of being divided between two. Another point to which he directs attention is the very limited extent to which "home-made" apparatus is employed in the laboratories.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, August 31.—M. Bouquet de la Grye in the chair.—A fixing liquid isotonic with sea water, for objects in which it is desired to preserve lime formations, by M. M. C. **Dekhuyzen**. In a previous note a formula has been given for a liquid, isotonic with sea water, for fixing delicate marine organisms. This contains acid, and in fixing the larvæ of sea urchins, which contain extremely delicate chalk formations, it is necessary to employ a liquid free from acidity. The formula of a liquid possessing the required properties is given in the present paper, and in the hands of M. Delage has given perfect results in fixing very delicate larvæ.

GÖTTINGEN.

Royal Society of Sciences.—The *Nachrichten* (physico-mathematical section), part iii. for 1903, contains the following memoirs communicated to the society:—

February 21.—W. **Voigt**: Questions of crystalline physics, i. On the rotatory constants of heat-conduction in apatite and dolomite.

March 7.—W. **Kaufmann**: On the "electromagnetic mass" of the electrons. V. **Cuomo**: Measurements of the electric dispersion in the open air at Capri (October, 1902–February, 1903).

May 16.—W. **Voigt**: On the theory of total reflexion. K. **Schwarzschild**: Contributions to electrodynamics—(1) two forms of the principle of least action in the theory of electrons; (2) the elementary electrodynamic force.

June 13.—F. **Merkel**: Remarks on the fasciæ and veins of the human pelvis.

The "Business Communications," part i. for 1903, contain a report on the Samoa Observatory, and a highly appreciative obituary notice of the late Sir G. G. Stokes, by Prof. W. Voigt.

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